

Determining "Ground Truth" In The New Jersey STRATAFORM Natural Laboratory

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LONG-TERM GOALS

Understand the creation of preserved stratigraphy along continental terraces, by linking sedimentation processes to preserved sequence stratigraphy and facies architecture.

OBJECTIVES

As part of STRATAFORM, the University of Texas Institute for Geophysics (UTIG) and collaborators are continuing to integrate "nested" seismic data available off New Jersey with subsurface samples of various kinds, as they become available. This primary STRATAFORM goal remains elusive off New Jersey, because "ground-truthing" of seismic sequence boundaries and intervening facies by sampling at all relevant depths is ongoing but is as yet incomplete. The objectives are: 1) to study the history of sea-level change over the past ~35 Ma, and 2) to determine the effects of various depositional and erosional processes on the preserved continental margin sediment record, from the seafloor to subbottom depths of ~100 m.

APPROACH

Task 1: a) integrate regional high-resolution MCS with ODP cores and downhole logs and b) correlate Huntet 2D/3D and chirp sonar control with grab samples and vibra-cores (STRATAFORM tasks C1, C4, C5)

- Finish interpreting high-resolution MCS profiles collected for STRATAFORM in 1995 in the context of Ocean Drilling Program (ODP) Leg 174A drilling results and existing MCS interpretations on the shelf and upper slope (Fulthorpe, Austin, Olson).
- Link outer shelf and upper slope stratigraphic regimes, by tying ODP Leg 174A and Leg 150 results seismically, in order to understand source-to-sink sediment dispersal systems (Fulthorpe, Austin).

Task 2: calibrate shallow subsurface seismic stratigraphy, in order to assess the preservation potential of the New Jersey shelf succession (STRATAFORM tasks C2, C4, C5, C6c)

- Ascribe physical significance to existing 2D and 3D seismic images of surficial seismic stratigraphy through analysis of core samples (Austin, Fulthorpe, Olson, Duncan).

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- Investigate the apparent lack of coherence between the modern sea floor and the shallowest subsurface (Goff, Olson, Duncan).

WORK COMPLETED

Analysis and integration of results from Leg 174A, conducted in June-July 1997, are continuing; at UTIG, the analysis and integration is being led by Fulthorpe with help from Austin. Two sites (1071 and 1072) were drilled on the shelf, and a third (1073) was completed on the upper continental slope. All are contained within a grid of high-resolution MCS profiles collected as part of STRATAFORM in 1995.

Since UTIG collected its first 3D Hunttec data on the New Jersey shelf in 1989, a primary objective has been ground-truthing the ultra-high resolution images. Short piston cores were acquired after the 1989 survey; a suite of vibra-cores was collected in association with the second 3D survey in 1993. A test of the *Marion Dufresne*-based CALYPSO corer took place in June 1999; shelf penetrations in the vicinity of the 1989 3D survey were either completely unsuccessful or did not greatly exceed the ~5 m vibra-cores recovered in 1993 (and this recovery may have been flow-in). PROD ("Portable Remotely Operated Drill") coring (to subbottom depths of 30 m) may take place in the summer of 2000, if the PROD technology, now being developed in Australia, is found to be viable. A test of the PROD system in Australia will be observed by Austin in November 1999.

A comprehensive geological/geophysical characterization of the uppermost middle-outer New Jersey shelf is also underway, building upon multi-beam backscatter/bathymetric imaging of the seafloor and 2D/3D ultra-high resolution geophysical control collected in accordance with **Tasks C2 and C5**. Surficial sediment (grab-) sampling efforts, along with chirp and sidescan-sonar surveys, have been led by Goff at UTIG, with support from Olson, Austin, Schuur (now Duncan) and others. Approximately 300 grab samples were collected (under a separate contract to Goff and Austin from the U.S. Science Support Program of ODP) in 1998, to assess the lithostratigraphic signatures of 95 kHz sidescan coverage collected over the middle-outer shelf in 1996. Duncan continues her Ph.D. dissertation on the stratigraphic relationships among Hunttec 2D/3D control, chirp sonar data, and both grab samples and short (up to ~5 m) vibra-cores collected on the middle-outer shelf in 1993.

RESULTS

Isopach/structure maps of Miocene to Pleistocene shelf sequence boundaries and downlap surfaces (indicators of maximum flooding) beneath the New Jersey shelf and upper slope are beginning to illustrate the sediment distribution through time (Austin, Christie-Blick, Malone et al., 1998; Fulthorpe and Austin, 1998). Such mapping is the focus of **Task C1**, which mandated contouring thicknesses and describing facies of mid-shelf to upper slope sequences. Understanding these shelf/slope systems is the ultimate objective of **Task C4**, which mandated that "high-resolution" 2D MCS control be acquired, analyzed and interpreted across the shelf-slope break. Fulthorpe et al. (1999) have shown that rivers discharged near the paleo-shelf edge during some Miocene sea-level lowstands (Figure 1). However, slope canyons probably formed independently of such fluvial systems. Although such canyons did form during lowstands, their presence appears to have been controlled by local conditions (e.g., efficiency of sediment transport, rate of sediment supply, grain size, spring-sapping?) other than sea level (Fulthorpe et al., in press).

As a result of studies completed since the first vibra-cores were collected in 1993, we now know that the surficial, latest Pleistocene-Holocene stratigraphy is: 1) complicated (Buck et al., 1999), and 2) not directly related to seafloor morphology. However, reworking does not extend to great depths, perhaps not more than ~0.5 m sub-sea floor. Another complexity arises from the stratigraphy associated with filled, meandering channels in the surficial section; these have been imaged by both the 1989 and 1993 Hunttec 3D surveys. Vibra-cores results indicate that channels in the mid-shelf wedge are mud-filled and carved into sands (Buck et al., 1999); earlier piston-coring suggests that outer shelf wedge channels are sand-filled. Detailed information on Quaternary sea-level and climate change (i.e., glacial-interglacial variations) and related depositional processes is recorded in overall faunal content, as well as the distribution of benthic foram (*Elphidium*) subspecies (Buck and Olson, in revision). Duncan et al. (in revision) have developed a model in relating the observed Hunttec stratigraphy to depositional processes associated with the last transgression (~18-7 ka) across the New Jersey margin; this is an important part of **Task C6c** (Figure 2). However, the stratigraphic succession associated with these interconnected(?), coeval(?) drainage systems is as yet unexplained, because the number and length of the subsurface samples collected to date are insufficient to unravel their stratigraphic complexities.

The new grab sample data are being interpreted by Goff, Olson, Duncan and co-workers in the context of the preexisting sidescan/bathymetric coverage of the shelf. Sand ridges form in the nearshore environment, but their gross morphology does not change beyond ~20 m water depth. On the mid-shelf, high backscatter along ridge crests implies that they are winnowed, relict features. Ribbon-floored swales represent erosion of this relict morphology. Iceberg scours on the Hudson Apron are preserved by outcropping stiff clays (Goff et al., 1999; in press). Goff et al. (submitted) demonstrate an unprecedented correlation between backscatter intensity and mean grain size, except that backscatter is unusually affected by larger grain sizes like shell hash.

IMPACT/APPLICATIONS

The seismic coverage generated by STRATAFORM has been an important part of the Mid-Atlantic Sea Level Transect, whose long-term goal has been to understand the effects of global changes of sea level, among other forcing factors, on the formation and preservation of stratigraphy over the past ~35 Ma. The sampling being undertaken as part of this grant will provide the high-resolution ground truth necessary to look in detail at the latest Pleistocene-Holocene part of the eustatic record, tie it systematically to litho- and biofacies beneath the New Jersey mid- and outer shelf, and calibrate the shallow subsurface seismic stratigraphy that has been (Duncan et al., in revision) and is being developed for this margin.

TRANSITIONS

PROD coring may take place aboard the WHOI research vessel *Knorr* in summer 2000. Those cores, most of which will be collected within previously collected Hunttec 2D/3D coverage, should provide the basis for another planned ONR research initiative off New Jersey, "Geoclutter."

RELATED PROJECTS

STRATAFORM and ODP (an international program funded through NSF) have both played prominent roles in ongoing New Jersey research. STRATAFORM sampling envisioned for 2000 should provide the basis for additional 3D chirp sonar imaging and acoustic reconnaissance planned as part of the proposed ONR "Geoclutter" initiative.

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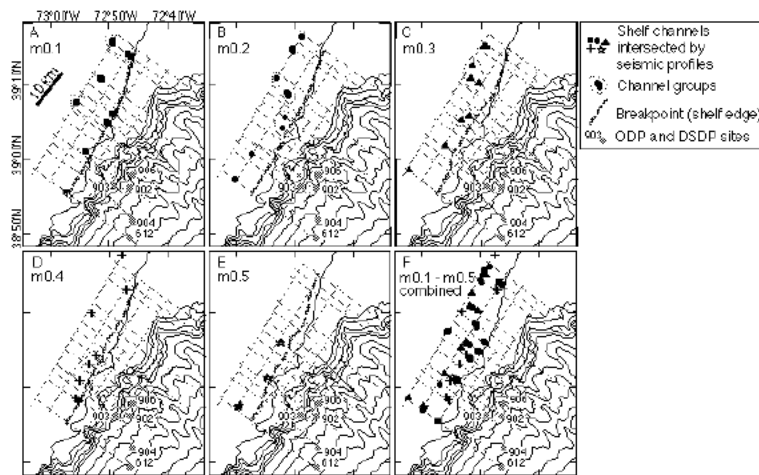


Figure 1. Seismic crossings of shelf channels incising upper Miocene sequence boundaries. Position of the clinoform breakpoint/paleo-shelf-edge is shown for each boundary. Fluvial systems appear to have occurred at ~10-15 km intervals. Panel F superimposes channels from all five boundaries. The uniform distribution over time (probably several million years) suggests that river systems migrated rapidly as progradation occurred (from Fulthorpe et al., 1999).

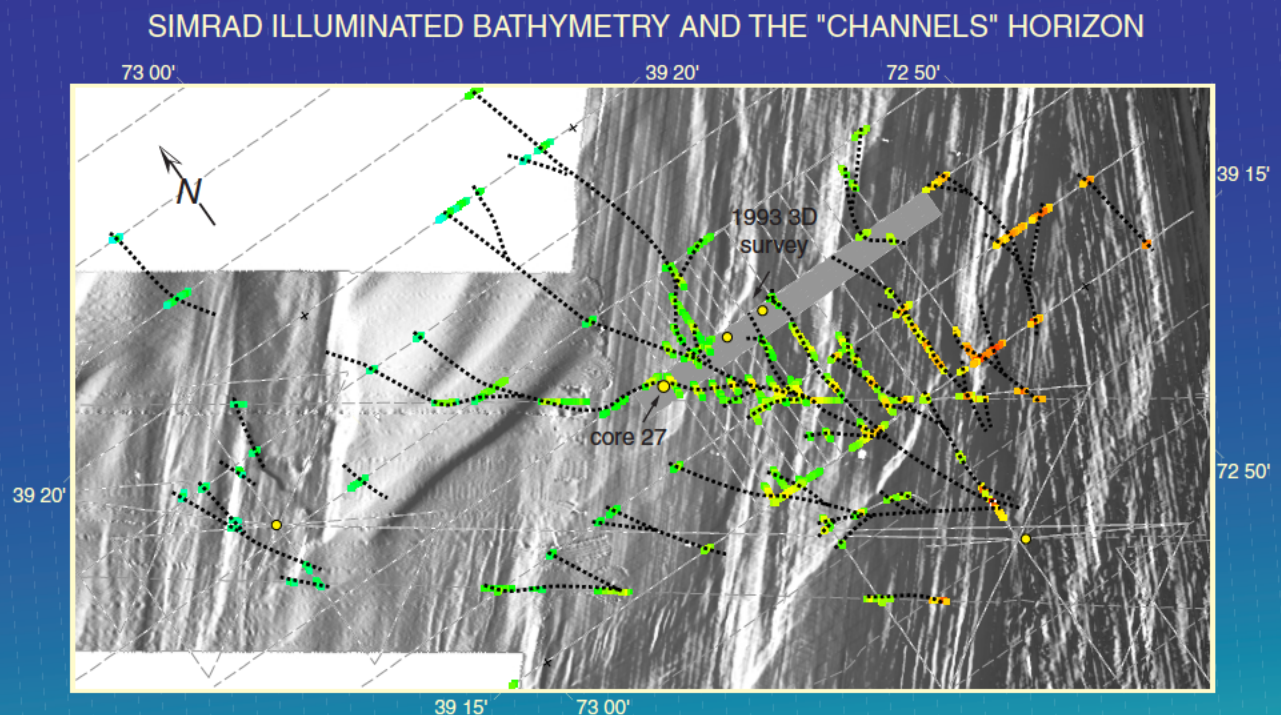


Figure 2. Mapped distribution of shallowly buried subsurface channels, superimposed on Simrad EM1000 swath bathymetry (100% coverage), covering a portion of the New Jersey mid- and outer continental shelf. The long rectangle is a 3D volume, embedded within a grid of E-W and N-S 2D profiles. All seismic profiles were collected using the Huntect DTS boomer system. (Illustration courtesy L. Duncan, UTIG, from Duncan, Goff, Austin, and Fulthorpe, in revision, Marine Geology)